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ORIGINAL PAPER

The Mindfulness-Based Kindness Curriculum for Preschoolers: An Applied Multi-Site Randomized Control Trial

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Abstract

Objectives This study examined the impact of the Mindfulness-Based Kindness Curriculum (MBKC) on social-emotional, executive function, and academic skills of preschoolers.

Method Sixteen preschool and 4K (4-year-old kindergarten) classrooms (245 children, 57.6% ethnically diverse, 69.8% low SES) were randomly assigned to either a curriculum-as-usual (CAU) or MBKC group taught by trained classroom teachers. Measures, as reported by children, teachers, and parents, were collected prior to and after implementation of the MBKC.

Results Trained classroom teachers effectively implemented the MBKC. Teachers rated MBKC children significantly higher on outcome measures of social-emotional skills (e.g., sharing, prosocial skills, empathy), executive functioning (e.g., planning/organizing, working memory), and academic skills (e.g., physical development, language, math) than CAU children. Parents rated MBKC children as having significantly higher levels of cognitive empathy compared to parents' ratings of CAU children. MBKC children were significantly more likely to engage in sharing behavior with a sick child, though children's self-ratings indicated no effect of the MBKC on mindfulness skills or self-efficacy. Unlike previous research, the MBKC did not benefit initially lower functioning children more than initially higher functioning children.

Conclusions Consistent with previous research, children given the MBKC appeared to benefit in terms of higher social-emotional competency, prosocial behavior, and executive functioning. The MBKC proved to be a useful complement to their other social-emotional learning programming. The present study expands the literature on the application of mindfulness with preschool children and highlights important implications of teaching and measuring mindfulness skills in young children, thereby identifying specific issues to address in future studies.

Preregistration This study was not preregistered.

Keywords Mindfulness · Early childhood · Mindfulness-based interventions · Executive function · Preschool · Social-emotional

Mindfulness has been conceptualized along a continuum ranging from the application of precise skills of awareness to a more stable, global, personality construct (Bishop et al., 2004). This research, like others examining mindfulness interventions, conceptualizes mindfulness as a cultivated skill marked by openness and willingness to experience oneself and the environment in the present moment in a nonjudgmental and accepting manner (Kabat-Zinn, 2005). The application of mindfulness is considered beneficial for promoting emotional awareness (Emanuel et al., 2010; Hong et al., 2016), self-regulation (Bishop et al., 2004; Kabat-Zinn, 2005), and executive functioning (Janz et al., 2019; Zelazo & Lyons, 2012).

Self-regulation refers to the ability to modulate attention, thoughts, emotions, and behaviors to successfully adapt to environmental demands and accomplish long-term goals (Blair & Razza, 2007). Seminal research suggests adaptive and flexible self-regulation: (a) stimulates motivation to learn and social-emotional intelligence, thereby promoting academic functioning, (b) increases engagement in empathic and prosocial behaviors (e.g., compassion, sharing), and (c) promotes development of meaningful and supportive relationships via social-emotional competence (e.g., Blair, 2002;

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Janz et al., 2019). Thus, from a developmental perspective, self-regulation is a fundamental building block for more refined social-emotional capabilities. Effective application of self-regulation skills during formative years is considered a hallmark of healthy social-emotional and cognitive functioning and contributes to success across multiple life domains (Claessens & Dowsett, 2014), positively predicting financial, physical, and mental health outcomes in adulthood (Moffitt et al., 2011).

Executive functioning encompasses mental processes including cognitive flexibility, inhibitory control, working memory, and decision-making, which are central to both academic performance and general intelligence (Blair & Razza, 2007; Zelazo et al., 2008). Janz et al. (2019) showed that a mindfulness-based intervention (MBI) resulted in higher executive functioning on cognitive flexibility and inhibitory control tasks among PreK to 2nd grade children compared to waitlist control children. Children's task improvements corresponded with teacher reports of the MBI children showing more improvements in emotional symptoms, conduct problems, and hyperactive/attention difficulties.

The application of mindfulness is thought to advance self-regulation and executive function in tandem. Self-regulation and executive function skills are fundamental building blocks that potentially pave the way for development of more nuanced skills such as empathy, prosocial abilities, academic achievements, and overall social-emotional well-being (e.g., Janz et al., 2019; Sun et al., 2021). Additionally, self-regulation and executive function operate in a reciprocal manner such that enhancement or promotion of either during the formative early years reverberates positively in the other, resulting in psychologically healthier development than the development of either alone (Zelazo & Lyons, 2012). Consequently, increasing the ability to direct and regulate attention to the present moment through mindfulness activities encourages refinement of self-regulation (e.g., modulation of attentional, emotional, and behavioral reactions to external stressors) and executive function (e.g., increased sustained attention and cognitive flexibility) leading to better social-emotional skills (Zelazo & Lyons, 2012).

Goldberg et al. (2021) extensively reviewed 160 effects of mindfulness-based interventions (MBIs) reported in 336 randomized clinical trials across 44 meta-analyses with children/adolescents, adults, students, employees, and health care professionals. Although less robust compared to the adult findings, MBIs proved consistently more beneficial for children and adolescents across outcomes (e.g., depression, anxiety, pain, physical symptoms, sleep, and mindfulness) when compared to *passive* and *active* controls.

Dunning et al. (2019) conducted a meta-analysis including 33 randomized controlled trials (RCTs) with a total of 3,666 children and adolescents to examine mindfulness effects on cognitive, behavioral, and emotional factors. MBIs promoted better mindfulness skills, executive functioning, and attention, and lower levels of depression, anxiety/stress, and negative behaviors (Cohen's $d = 0.16$ to 0.30). More specific comparisons of MBIs to active controls (17 of 33 RCTs) yielded less robust effects such that significance was observed only for better mindfulness skills ($d = 0.42$), lower depression ($d = 0.47$), and lower anxiety/stress ($d = 0.18$), but not for executive functioning and negative behaviors, confirming the assertion by Goldberg et al. (2021) that comparing MBIs to passive controls may artificially inflate the apparent success of MBIs.

In reviews focused on young children (3 to 6 years old), teachers reported mindfulness practices in the classroom to be effective and feasible in addressing emotional and behavioral dysregulation and promoting self-regulation and executive function (Razza et al. 2020), particularly with children requiring additional support (Bockmann & Yu, 2022; Sun et al., 2021). Although reviews noted mixed findings across measures of self-regulation in young children, overall, MBIs promoted self-regulation and positive social-emotional development. More specifically, Bockmann and Yu (2022) examined 18 studies spanning from 2010 to 2021 and found mixed effects of MBIs on self-regulation skills across children. However, benefits of MBIs more consistently emerged in vulnerable children or children from higher risk communities (i.e., economically disadvantaged or high trauma communities). Similarly, the literature review by Sun et al. (2021) concluded that yoga and mindfulness interventions for preschool-aged children in school settings led to self-regulatory and executive functioning gains, again differentially and more positively affecting children with established lower baseline social-emotional functioning. Although the reviews generally indicate MBIs promote emotional and behavioral regulatory functioning in young children, the lack of consistency across different outcome measures, variability in the length and focus of the MBIs, and differential beneficial effects for children with initial lower baseline functioning highlight the need for larger studies of MBIs with diverse samples and measures of children's self-awareness of their mindfulness and self-regulation skills (Bockmann & Yu, 2022; Sun et al., 2021).

In general, quasi-experimental and randomized clinical studies have concluded that inclusion of mindfulness in classrooms promotes executive functioning (e.g., working memory; Thierry et al., 2016), neuropsychological functioning (e.g., increase in non-verbal development, visual perceptions, and attention; Moreno-Gomez & Cejudo, 2019), and enhances psychosocial adjustment (e.g., reduction in externalized behaviors and academic problems; Moreno-Gomez & Cejudo, 2019). Berti and Cigala's (2022) RCT pilot study included 21 preschoolers who engaged in either a 6-week MBI consisting of mindfulness play and meditation or curriculum-as-usual (CAU). They reported children in the

MBI demonstrated significant improvements in self-regulation (particularly in the inhibition of impulsive behaviors), prosocial behavior, and perspective taking.

Two matched-control studies by Thierry et al. (2018, 2022) further highlight the benefits and feasibility of including school-based MBIs for minority children from economically disadvantaged backgrounds. The first study consisted of 296 four-year-old children (97% African American and Latinx) across eight schools (Thierry et al., 2018). The second consisted of 400 diverse, somewhat older children ($M = 6.69$) in either a mindfulness practice or CAU condition (Thierry et al., 2022). In both studies, the MBI curriculum focused on self-regulation and self-awareness (e.g., understanding what is happening in their brain when they are dysregulated). Although no significant differences in prosocial behaviors and academic skills were found in the 2018 study, significant MBI improvements were found in executive functioning. The authors concluded the significant executive function findings may be due to the mindfulness program targeting self *vs.* other awareness, thus the scope of the benefits may have been limited to executive functioning. In the 2022 study, Thierry et al. found that somewhat older children receiving the mindfulness intervention did better at recognizing emotions, and similar to Sun et al. (2021) and Bockmann and Yu (2022), the effects were more pronounced for children scoring lower at the pre-intervention assessment.

As noted above, MBIs with young children vary considerably in focus (e.g., self vs. other oriented mindfulness) and length (e.g., the 2021 review by Sun et al. found significant improvement only among MBIs of 6 weeks or longer). Also, many studies do not explain whether the usual classroom curriculum included a social-emotional learning (SEL) focus and might be considered an active control. That is, SEL programs target similar outcomes as MBIs. Indeed, a meta-analysis of 213 SEL programs found significant gains in socio-emotional outcomes for SEL participants vs. control participants (Durlak et al., 2011).

Flook et al. (2015) used the Mindfulness-Based Kindness Curriculum (MBKC; Healthy Minds Innovation, 2017) with 24 lessons over 12 weeks focused on social-emotional skills, and both self- and other-mindful awareness, taught by mindfulness experts. They directly assessed social-emotional skills including prosocial skills (i.e., sharing) and social competence, academic performance, self-regulation (i.e., delay of gratification), and executive functioning. Of the 68 children in seven pre-kindergarten classrooms in six public schools, 37.9% were socioeconomically disadvantaged and 41.2% identified as an ethnic minority. They found greater social competence, improved sharing behavior, and academic success (e.g., higher health and social development grades), in children receiving the MBKC compared to children receiving CAU. There was some evidence of higher cognitive flexibility and better delay of gratification favoring MBKC children, though the interactions with condition were not statistically significant. Similarly, Poehlmann-Tynan et al. (2016) implemented the same MBKC, also with external instructors, with 29 lower socioeconomic (SES) preschoolers (3 to 5 years). Although another small sample, they found significant increases for the MBKC group in attentional focus and self-regulation post intervention and at a 3-month follow up, but not in empathy or compassion.

The present study replicates MBKC research by Flook et al. (2015) and Poehlmann-Tynan et al. (2016) and extends it in several ways. We used a larger, diverse sample of children and a broader range of measures including direct assessments of children as well as parent and teacher reports of children's self-regulation, social-emotional (e.g., empathy, sharing), executive functioning, and mindfulness skills. Further, we developed a mindfulness scale to measure more objectively how well preschool children could identify and apply mindfulness skills learned in the MBKC. Inclusion of classrooms already using an established SEL curriculum provided a stricter test of potential benefits of the MBKC. In addition, measures of lesson adherence addressed the feasibility of training classroom teachers, rather than mindfulness experts as in the earlier MBKC studies, on mindfulness practices and to implement the curriculum. It is not always possible nor cost-effective to have mindfulness experts administer MBIs (e.g., Razza et al., 2020). Further, trained classroom teachers can embody mindful attitudes and embed mindfulness practices meaningfully throughout the day (Meiklejohn et al., 2012), which may help children to cultivate skills and provide added benefits to children and teachers. For example, Singh et al. (2013) found that training preschool teachers on mindfulness reduced problematic behaviors and promoted cooperation in the classroom. Other studies report that teachers find mindfulness practices to be feasible and effective in their classrooms (e.g., Bockmann & Yu, 2022). Moreover, mindfulness training can be supportive of teachers' well-being and emotional self-regulation (Bockmann & Yu, 2022; Hwang et al., 2019; Schussler et al., 2019).

We hypothesized that children receiving the MBKC would demonstrate higher self-regulation and executive functioning skills as well as skills associated with higher self-regulation and executive function such as empathy, prosocial behaviors, social competency, mindfulness (self- and other-oriented), and behavioral control/inhibition as reported by the children themselves, parents, and teachers. Additionally, consistent with the previous literature, we expected the benefits of mindfulness for the children would be more pronounced for children with lower baseline scores.

Method

Participants

Children were recruited from an Even Start program, a Head Start site, and two public non-profit early learning centers in the Midwestern United States. A total of 16 classrooms from these four sites took part in the study (eight preschool and eight 4-year-old kindergarten (4K) classrooms), and the parents of 245 children (98% of the 250 approached) consented to participation. Preschool classrooms served ages 3 to 5 years, and 4K classrooms served ages 4 to 5 years. The 245 children were ethnically diverse (White, 104, 42.45%; Hispanic, 59, 24.08%; African American/Black, 33, 13.47%; Asian, 29, 11.84%; mixed/other, 20, 8.16%). Most children were low income (168, 69.75%), monolingual English speakers (187, 76.33%; bilingual primarily English and Spanish, 41, 16.8%; Hmong speakers, 13, 5.31%), male (132, 53.87%), and ranged in age from 28 to 62 months ($M = 4.2$ years, $SD = 7.4$ months).

Procedure

Children were randomly assigned by classroom to a waitlist control group in which they received CAU opportunities (6 classrooms) or the Mindfulness-Based Kindness Curriculum (MBKC, 10 classrooms) intervention plus the regular educational opportunities. Teachers were comparable in years of teaching experience between the MBKC group ($M = 10.95$, $SD = 6.97$) and CAU group ($M = 12.26$, $SD = 7.75$). Fourteen of the 16 classrooms (2 MBKC classrooms did not) included implementation of the SEL Pyramid Model (Hemmeter et al., 2016), an established protocol for promoting social-emotional competence, providing a more rigorous test of added MBKC benefits. During the 6 weeks prior to and about 4 weeks after the administration of the MBKC and CAU, children were assessed individually on social-emotional, executive functioning, and self-regulation self-report and task-based measures. Data were gathered by trained undergraduate and graduate research assistants, certified on each task, and supervised by professors from two universities. Research assistants were blind to participants' condition assignment. Teachers also rated children on their social emotional skills, executive functioning, and academic and developmental skills. Teachers were not blind to condition as they delivered the MBKC or CAU. Teachers and parents rated children's empathy skills and prosocial behavior. See Supplementary Materials for a diagram of the study flowchart.

Mindfulness-Based Kindness Curriculum The MBKC group received 12 weeks of teacher-led mindfulness-based prosocial skills training designed for preschool children (Flook et al., 2015; Healthy Minds Innovations, 2017). The MBKC includes 24 lessons (each 15 to 20 min) grouped into eight themes (e.g., emotion expression, self-calming, and gratitude; see Supplementary Materials for MBKC lessons and themes and information on teacher training). The MBKC lessons promote an understanding and application of non-judgmental acceptance, awareness to the present moment, and kindness to self, others, and the environment via children's literature, music, and movement. It is assumed that the promotion of mindfulness will facilitate these outcomes by enhancing self-regulation, behavioral control, and executive functioning. Prior to MBKC implementation, lead classroom teachers, agency leaders, and two project mindfulness coaches received 26 hr of training by expert mindfulness coaches to develop their own mindfulness practice and teach the MBKC lessons. Mindfulness coaches provided materials and support to teachers as they cultivated their mindfulness practice and during MBKC implementation. MBKC parents received five letters about the MBKC lessons. All parents received access to a family mindfulness website and the opportunity to take a 5-week mindfulness class following MBKC implementation.

Measures

Teacher Adherence and Acceptability Teachers completed weekly fidelity reports on two MBKC lessons, indicating whether they completed each lesson component (9 to 10/lesson), rating adherence to each on a 7-point scale, and noting time spent on each of the 24 lessons (see Supplementary Materials for sample adherence forms). After the teachers completed teaching the MBKC, they rated acceptability of the MBKC on a 5-point scale for 8 items about curriculum usefulness, children's acquisition of key concepts, classroom impact, intent to keep using, impact on personal mindfulness practice, and support and helpfulness of mindfulness coaches.

Mindfulness Children's Assessment Task Scale (MCATS) The MCATS, developed for this study using the Mindful Attention Awareness Scale adapted for Children (originally designed for children in 4-7th grade; Lawlor et al., 2014), measures children's acquisition of mindfulness skills and application of those skills in fostering kindness to self, others, and the immediate environment as taught in the MBKC for preschool age children (Haines et al., 2019). For example, the item, "Usually, I do not notice if my body feels tense or uncomfortable until it gets really bad" was simplified to "Do you notice when your body feels tense or upset?" for

the MCATS. The MCATS consists of 17 illustrated items (see Supplementary Materials for full scale and pilot testing information), rated along a 9-point scale (1 = *never*; 5 = *sometimes*; 9 = *always*) forming three subscales: Self-Mindfulness/Regulation (SMR, e.g., "Do you calm yourself by breathing?", Cronbach's α pre/post = 0.56/0.53); Self-Oriented Kindness (SOK, e.g., "When you're sad, are you kind and gentle with yourself?", Cronbach's α pre/post = 0.52/0.53); and Other-Oriented Kindness (OOK, e.g., "When someone else is sad, do you try to help?", Cronbach's α pre/post = 0.60/0.58). Higher scores on each subscale indicate higher levels of mindfulness.

Social Self-Efficacy Scale (SSES) The SSES (three subscales adapted from Bandura, 2006) contains 15 items rated along a 9-point scale (1/frown face = *Not Sure*; 5/neutral face = *Kind of Sure*; 9/smiling face = *Very Sure*) to assess children's perceived confidence in achieving certain social goals with higher scores indicating greater confidence. The three SSES subscales include: Self-Regulatory Efficacy (SRE, Cronbach's α pre/post = 0.60/0.58), Social Self-Efficacy (SSE, Cronbach's α pre/post = 0.65/0.62), and Self-Regulated Learning (SRL, Cronbach's α pre/post = 0.73/0.65) to measure perceived ability to control emotions and behaviors, to engage in prosocial behaviors and sustain peer relationships, and to control their learning process, respectively. Items are accompanied by gender-matched illustrations to facilitate understanding.

Sharing Task The sharing task (Flook et al., 2015) assesses children's willingness to share stickers across five separate trials. In Trials 1 to 4, children allocated 10 stickers to either themselves or a target recipient (most-liked peer, least-liked peer, unfamiliar child, and sick child) by distributing the stickers between two envelopes (red for themselves, blue for the designated recipient). The score is percentage of stickers shared with each target. In Trial 5, children distributed a total of 10 stickers among the four target recipients considered in each of the earlier trials (i.e., most-liked, least-liked, unfamiliar, sick). An "in-need" score was calculated based on the percentage of stickers given to the sick child compared to the other three choices. Finally, an "others" score was calculated based on the average percentage of stickers shared with any child target compared to themselves.

Balance Beam Task This task directs children to walk across a balance beam at their normal pace (Trial 1), at a "slower" pace (Trial 2), and then to go "even slower" (Trial 3; Smith-Donald et al., 2007). For each trial, duration of time (in centiseconds) to cross the balance beam, based on the instructions, provided a measure of self-regulation, bodily awareness, and control. Longer times (on slow and slower trials) indicate more behavioral control and intentional focus to the task.

Dimensional Change Card Sort Task (DCCS) The DCCS and Flanker Task, taken from the NIH Toolbox Cognitive Battery, were administered on an iPad (Zelazo et al., 2013). The DCCS assesses children's cognitive flexibility (e.g., shifting, inhibition, and working memory) and consists of three sorting test trial blocks: pre-switch (5 trials sorting by color), post-switch (5 trials sorting by shape), and mixed trials (30 trials varying sorting by color or shape). Correctly sorting 3 out of 4 practice items is needed to proceed in each test trial block, and iPad discontinuation occurs if children miss two or more in each test trial block. Upon iPad discontinuation, paper copies of the DCCS were administered and mirrored the electronic version except the mixed test trial block was reduced from 30 to 15 trials to decrease working memory demands among very young children (Fuhs et al., 2015; Rennie et al., 2004). The measure of cognitive flexibility was number correct on the first 15 mixed test trials following recommended scoring (Zelazo et al., 2013). Both the DCCS and Flanker have demonstrated strong test–retest reliability (ICC = 0.92 for both) and good validity (Zelazo et al., 2013).

Flanker Task The Flanker task assesses children's inhibition and working memory. Children view pictures with a row of five fish for which they indicate the direction that the middle fish faces while ignoring the direction of the other fish in the picture (20 trials). In 12 congruent trials, the surrounding fish face the same direction as the middle fish, and in 8 incongruent trials they face the opposite direction of the middle fish. Children received scores on number of correct responses on congruent and on incongruent trials. To proceed to each test trial block, children are required to correctly solve 3 out of 4 problems in up to three series of practice trials, otherwise test trial blocks are discontinued on the iPad. Children advanced to harder trials in which the target stimuli change to arrows (instead of fish) if they successfully passed the fish trials with no more than one error on each of the congruent and incongruent fish trials. The percentage of children successfully advancing to the harder trials was recorded as an additional outcome measure.

Teacher Rated Social Competence (TRSC) Teachers rated children's social competence on the TRSC (Conduct Problems Prevention Research Group, 1995), which consists of 12 total items across two subscales: Prosocial Behavior (PB, Cronbach's α pre/post = 0.96/0.96) and Emotional Self-Regulation (ESR, Cronbach's α pre/post = 0.92/0.93). Three items from the subscales were used to create the Empathic Behavior scale (EB, Cronbach's α pre/post = 0.91/0.91), allowing for more direct comparison with parents' ratings of their children's empathy. Prior to and following the intervention, teachers rated each child compared to other similar age children along a 6-point scale (0 = *almost never*; 5 = *almost always*). Higher mean scores indicate more social competence.

Behavior Rating Inventory of Executive Function—Preschool Version (BRIEF-P) Teachers rated children's executive functioning using a 3-point Likert scale (1 = *never*, 2 = *sometimes*, 3 = *always*) on the BRIEF-P (Gioia et al., 2000), which consists of five subscales: Behavioral Inhibition (BI, Cronbach's α pre/post = 0.97/0.96), Emotional Control (EC, Cronbach's α pre/post = 0.94/0.94), Task Shift (TS, Cronbach's α pre/post = 0.92/0.92), Working Memory (WM, Cronbach's α pre/post = 0.97/0.97), and Plan/Organize (PO, Cronbach's α pre/post = 0.94/0.93). Subscale scores were reverse computed so that higher scores indicate higher executive functioning.

Teaching Strategies-GOLD (TS-GOLD) The TS-GOLD (Heroman et al., 2010) has 38 learning objectives measuring progression in 10 developmental areas, six of which were measured in this study: Social-Emotional (SE; Cronbach's α pre/post = 0.95/0.93), Physical Development (PD; Cronbach's α pre/post = 0.88/0.84), Language (L; Cronbach's α pre/post = 0.94/0.94), Cognitive (C; Cronbach's α pre/post = 0.95/0.94), and academic content areas of Literacy (Li; Cronbach's α pre/post = 0.87/0.92), and Mathematics (M; Cronbach's α pre/post = 0.87/0.89). Teachers rated the child's progression on a 10-point scale ranging from Level 0 (not yet demonstrating the skill) to Level 9 (exceeding expectations) providing classroom observations of child participant's skills to support their rating. Higher scores indicate stronger skills or more advanced development.

Griffith Empathy Measure (GEM) The GEM (Dadds et al., 2008) consists of 23-items rated along a 9-point scale (Cronbach's α = 0.84; 1 = *Strongly disagree*; 9 = *Strongly agree*) that assess parental perceptions of their child's empathy along two subscales, a 6-item Cognitive Empathy subscale (CE; Cronbach's α pre/post = 0.66/0.62) and a 9-item Affect Contagion subscale (AC; Cronbach's α pre/post = 0.83/0.85), which assesses perspective taking and empathetic responding, respectively. Five items on the GEM, not used in the CE and the AC subscales, were combined to create an Other-Oriented Concern subscale (OOC; Cronbach's α pre/post = 0.74/0.79). Higher scores indicate higher empathy.

Ages and Stages Questionnaire-Social Emotional (ASQ-SE) Parents completed a version of the ASQ-SE questionnaire corresponding to their child's age (32 to 36 questions, e.g., "Does your child explore new places, such as a park or a friend's home?", "Does your child destroy or damage things on purpose?"). The ASQ-SE assesses children's global social-emotional competency (Squires et al., 2002) using a 4-point Likert scale (*never, rarely, sometimes*, *most of the time*). Higher values indicate higher social-emotional competency (ASQ-SE, Cronbach's α pre/post = 0.92/0.92).

Data Analyses

For most outcome measures, covariate analyses were conducted in which the mean posttest difference in the outcome measure by experimental condition (mindfulness vs. control) was evaluated using pretest scores on the outcome measure as a covariate. For each mean posttest difference, a partial eta square effect size was computed as was a 95% confidence interval for the difference when adjusting for the mean pretest score. Follow-up analyses were conducted in instances where the pretest covariate demonstrated a statistically significant interaction with experimental condition. To discern the pattern of interaction in these instances, mean differences on posttest scores were computed for the respective mean pretest score and for pretest scores 1 SD above and below the mean pretest score. If a case was missing a pre- or post-test score it was omitted from the analysis for that measure. Adjustments for multiple comparisons were not made.

One exception to this data analytic approach involved the children's performance on the balance beam task in which performance on the second and third performance trials were related to performance on the first and second performance trials, respectively. For this measure the difference in posttest scores by experimental condition for posttest Trial 2 and posttest Trial 3 were analyzed separately with posttest Trial 1 performance used as the covariate for analyses of posttest Trial 2 performance and posttest Trial 2 performance used as the covariate for analyses of posttest Trial 3 performance. A second exception to the general data analytic approach involved the measure of advancement to harder trials of the Flanker task. Specifically, the number of children scoring high enough to move on to more advanced trials (arrows) was recorded. For these data, a binary logistic regression was conducted in which pre-intervention success/failure (the covariate), intervention condition, and their interaction were used as predictors of post-intervention success/failure. For this measure, the 95% confidence interval is for the difference in proportion and the effect size is an odds ratio.

Results

Teacher Implementation Fidelity and Acceptability

Table 1 shows that teachers from both preschool and 4K classrooms spent an average of 18.2 min (*SD* = 5.97) on each lesson (designed to be 15–20 min). All mean ratings of adherence were above 5.65 on a 7-point scale and teachers completed an average of 87.4%–98.1% of the components within each MBKC theme. Two teachers with younger preschoolers or ELL children adapted lessons by selecting fewer components to complete. Teachers perceived the

Table 1 Teacher reports of lesson adherence, components completed, and time spent by theme

	Components completed *M* (*SD*)	Lesson adherence (for completed) *M* (*SD*)	Time spent on theme (3 lessons/theme) *M* (*SD*)
Theme 1: Mindful Bodies	28.11 (2.38)	5.65 (1.12)	58.28 (14.80)
Theme 2: Inside Emotions	27.33 (3.13)	5.71 (1.20)	60.00 (15.59)
Theme 3: Emotion Expression	26.22 (4.94)	5.89 (1.16)	54.33 (13.77)
Theme 4: Emotion Caretaking	25.78 (4.13)	6.02 (1.24)	54.38 (10.29)
Theme 5: Self Calming	29.43 (0.90)	6.13 (0.39)	52.50 (15.75)
Theme 6: Gratitude	26.22 (5.56)	5.93 (1.26)	56.56 (9.76)
Theme 7: Caring for Others	27.56 (3.83)	6.10 (1.25)	55.94 (14.68)
Theme 8: Caring for World	27.89 (3.03)	6.20 (1.35)	46.63 (12.60)

Each Theme has three lessons and most have 30 components (i.e., mindfulness concepts and activities); Theme 2 has 29 components. Teachers rated each component completed on a 7-point scale from 1 (introduced but did not explain/practice) to 7 (introduced, with detailed explanation/practice). Attendance at the 26-hr training was nearly perfect: one teacher missed three hours and one program leader missed one-half hour. See Supplementary Materials for sample adherence forms, overview of the MBKC, and teacher training information

acceptability of the MBKC positively, with high mean ratings on a 5-point scale of usefulness ($M = 3.92$, $SD = 0.67$), positive impact in the classroom ($M = 4.13$, $SD = 0.74$), and intent to keep using ($M = 4.38$, $SD = 0.83$).

Children's Self-Reports of Mindfulness Skills and Social Self-Efficacy

Descriptive statistics, confidence intervals, effect sizes, and *F*-ratios for covariate analyses of children's self-report measures are listed in Table 2. Covariate analyses revealed no statistically significant mean difference between experimental conditions for any of the mindfulness (MCATS) subscale measures, all *F*-values, $F(1, 217) < 1.99$, $p > 0.15$. For self-efficacy (SSES), covariate analyses revealed one statistically significant effect of experimental condition on the SRL subscale, $\eta_p^2 = 0.03$, $F(1, 217) = 6.88$, $p = 0.009$. CAU children reported higher self-regulated learning ($M_{adj} = 7.27$) than did MBKC children ($M_{adj} = 6.59$). However, no statistically significant effects of experimental condition were found for the other self-efficacy subscales, both *F*-values, $F(1, 217) < 2.58$, $p > 0.10$.

Children's Task Performance: Sharing, Balance Beam, DCCS, and Flanker

Table 3 lists descriptive statistics, confidence intervals, effect sizes, and F-ratios for covariate analyses of children's task performance measures. For sharing, covariate analyses revealed one statistically significant effect of experimental condition on sharing with a sick child, $\eta_p^2 = 0.02$, $F(1, 220) = 4.96$, $p = 0.027$. Children in the MBKC condition exhibited higher sharing with a sick child ($M_{adj} = 45.77$) than did children in the control condition ($M_{adj} = 38.74$). MBKC children also exhibited higher sharing on Trial 5 with a sick child than other targets ($M_{adj} = 26.35$), and overall higher sharing with other children (than keeping for self) across trials ($M_{adj} = 45.30$) than did CAU children ($M_{adj} = 22.48$ and $M_{adj} = 41.59$, respectively). However, both these mean differences were only marginally significant, $\eta_p^2 = 0.02$, $F(1, 217) = 3.41$, $p = 0.066$, and $\eta_p^2 = 0.01$, $F(1, 219) = 3.07$, $p = 0.081$, respectively. No statistically significant effects of experimental condition were found for any other sharing measures, all *F*-values, $F(1, 220–221) < 1.50$, $p > 0.22$.

Covariate analyses revealed no statistically significant effects of experimental condition for either of the balance beam measures, both $F(1, 242) < 0.34$, $p > 0.55$, or for the DCCS measure, $F(1, 219) = 0.46$, $p = 0.50$. On the Flanker, no statistically significant effect of experimental condition was found for the Fish-Incongruent measure, $F(1, 213) = 0.49$, $p = 0.49$. However, for the Fish-Congruent measure, there was a statistically significant mean difference between experimental conditions, $\eta_p^2 = 0.07$, $F(1, 213) = 14.86$, $p < 0.001$, which was qualified by a statistically significant interaction between the pretest covariate and experimental condition, $\eta_p^2 = 0.07$, $F(1, 219) = 14.91$, $p < 0.001$. As shown in Table 4, little difference in performance was found between the MBKC and CAU condition for children with average pretest scores. MBKC children performed worse than did those in the CAU condition among children with low pretest scores, but MBKC children performed better than did those in the CAU condition among children with high pretest scores.

In addition to examining performance on the easier fish trials of the Flanker task, the percentage of children successfully advancing to the harder arrow trials of the Flanker

Table 2 Children's mean (standard deviation) self-reports before and after intervention by experimental condition

Measure	Condition	Assessment time			95% CI		η_p^2	F
		Pre	Post	$Post_{Adj}$	LL	UL		
MCATS/mindfulness								
SMR (0.56, 0.53)	Control ($n=88$)	5.79 (1.75)	6.28 (1.69)	6.28	−0.81	0.13	0.01	1.99
	Mindfulness ($n=132$)	5.79 (1.83)	5.94 (1.79)	5.94				
SOK (0.52, 0.53)	Control ($n=88$)	6.19 (1.93)	6.48 (2.03)	6.45	−0.90	0.18	0.01	1.73
	Mindfulness ($n=132$)	5.80 (2.04)	6.06 (1.96)	6.09				
OOK (0.70, 0.67)	Control ($n=88$)	6.67 (1.74)	6.89 (1.71)	6.87	−0.31	0.56	0.00	0.31
	Mindfulness ($n=132$)	6.51 (1.84)	6.98 (1.60)	6.99				
SSES/self-efficacy								
SRL (0.60, 0.58)	Control ($n=89$)	6.57 (2.22)	7.30 (1.66)	7.27	−1.20	−0.17	0.03	6.88*
	Mindfulness ($n=131$)	6.35 (2.04)	6.57 (2.10)	6.59				
SRE (0.65, 0.62)	Control ($n=89$)	5.98 (2.03)	6.63 (1.52)	6.30	−0.78	0.12	0.01	2.11
	Mindfulness ($n=131$)	6.21 (1.82)	6.33 (1.78)	6.03				
SSE (0.73, 0.65)	Control ($n=89$)	6.53 (2.43)	7.26 (1.76)	7.30	−0.88	0.09	0.01	2.58
	Mindfulness ($n=131$)	6.88 (1.84)	6.93 (1.88)	6.90				

*$p<0.05$ (two-tailed). $^{+}p<0.10$ (two-tailed). Cronbach's alphas for scales are listed in parentheses beneath measure names. Standard deviations are listed in parentheses after means. *MCATS* Mindfulness children's assessment task and scale; *SMR* Self mindfulness/regulation; *SK* Self-oriented kindness; *OOK* Other-oriented kindness. *SSES* Social self-efficacy scale; *SRL* Self-regulated learning; *SRE* Self-regulatory efficacy; *SSE* Social-self efficacy. $Post_{adj}$ is the posttest mean adjusted for pretest scores. η_p^2 = Partial eta square for the effect of condition on the outcome variable with pretest score as a covariate. F = F-ratio for the difference in the outcome variable by condition with pretest score as a covariate

task was examined. Logistic regression revealed no significant difference in experimental condition on the percentage of children succeeding at harder posttest trials, $B=$ -0.10, $\chi^2(1)=0.09$, $p=0.77$, but did reveal a statistically significant interaction between pretest success at reaching more difficult trials and experimental condition, $Exp(B)=1.17$, $B=$ -2.15, $\chi^2(1)=5.38$, $p=0.020$. As shown in Table 4, among children who failed to reach the more difficult trials during the pretest, there was little difference in the percentage of children reaching the more difficult trials in the MBKC condition compared to the CAU condition. Among children who succeeded at reaching the more difficult trials during the pretest, the percentage of children reaching the more difficult trials at posttest in the MBKC condition was higher than that of CAU children.

Teachers' Ratings of Children

Table 5 lists descriptive statistics, confidence intervals, effect sizes, and F-ratios for covariate analyses of teachers' ratings of children. For Teacher Rated Social Competence, covariate analyses revealed statistically significant effects of experimental condition on the Prosocial Behavior and Empathic Behavior subscales, $\eta_p^2=0.07$, $F(1, 223)=16.98$, $p<0.001$, and $\eta_p^2=0.08$, $F(1, 223)=18.33$, $p<0.001$, respectively. MBKC children were rated as more prosocial ($M_{adj}=3.57$) and empathic ($M_{adj}=3.40$) than were CAU children ($M_{adj}=3.07$ and $M_{adj}=2.90$, respectively). No statistically significant effect of experimental condition was found for the Emotional Self-Regulation subscale, $F(1, 223)=2.48$, $p=0.12$.

For executive function (BRIEF-P), covariate analyses revealed statistically significant effects of experimental condition on the Working Memory and Plan/Organize subscales, $F(1, 223)=6.04$, $p=0.015$ and $F(1, 223)=6.21$, $p=0.013$, respectively. Children in the MBKC condition were rated as having better working memory and planning/organization ($M_{adj}=2.63$ and $M_{adj}=2.63$) than CAU children ($M_{adj}=2.49$ and $M_{adj}=2.49$). For the Task Shift subscale only a marginally significant effect of experimental condition was found, $\eta_p^2=0.01$, $F(1, 223)=2.78$, $p=0.097$, $\eta_p^2=0.01$, such that MBKC children were rated better at task shifting ($M_{adj}=2.71$) than CAU children ($M_{adj}=2.62$). The effect of experimental condition on Emotional Control mean subscale scores was marginally significant, $\eta_p^2=0.01$, $F(1, 222)=2.84$, $p=0.093$, and qualified by a marginally significant interaction between pretest scores and experimental condition, $\eta_p^2=0.02$, $F(1, 222)=3.59$, $p=0.06$. As shown in Table 4, there was little difference between conditions in ratings of emotional control for children with low and average pretest scores, but MBKC children were rated higher in emotional control than CAU children if they had high pretest scores. Finally, although the effect of experimental condition on Behavioral Inhibition scores was not

Table 3 Children's mean (standard deviation) task performance before and after intervention by experimental condition

Measure	Condition	Assessment time			95% CI		η_p^2	F
		Pre	Post	$Post_{Adj}$	LL	UL		
Sharing task								
Most liked	Control ($n=88$)	47.61 (22.18)	47.61 (18.88)	47.30	−6.72	5.13	0.00	0.07
	Mindfulness ($n=135$)	41.26 (20.88)	46.30 (23.40)	46.50				
Least Liked	Control ($n=88$)	46.48 (27.12)	38.86 (22.25)	38.49	−2.43	10.38	0.01	1.50
	Mindfulness ($n=135$)	42.71 (27.93)	42.22 (25.12)	42.47				
Unfamiliar	Control ($n=89$)	45.17 (27.60)	43.82 (22.84)	43.17	−3.53	9.61	0.00	0.83
	Mindfulness ($n=135$)	40.74 (27.36)	45.78 (26.61)	46.21				
Sick	Control ($n=89$)	43.03 (26.69)	38.99 (21.85)	38.74	0.81	13.25	0.02	4.96*
	Mindfulness ($n=134$)	41.12 (28.54)	45.60 (25.06)	45.77				
In need	Control ($n=87$)	26.32 (16.50)	22.44 (13.97)	22.48	−0.26	8.26	0.02	3.41^+
	Mindfulness ($n=133$)	27.64 (21.26)	26.38 (15.94)	26.35				
Others	Control ($n=88$)	45.89 (19.22)	42.27 (14.93)	41.59	−0.46	7.88	0.01	3.07^+
	Mindfulness ($n=134$)	41.44 (18.40)	44.85 (16.96)	45.30				
Balance beam task								
Walk	Control ($n=96$)	-----	4.07 (2.38)	-----	-----	-----	-----	-----
	Mindfulness ($n=149$)	-----	3.75 (2.18)	-----				
Slower	Control ($n=96$)	-----	7.36 (4.52)	7.15	−0.82	1.52	0.00	0.34
	Mindfulness ($n=149$)	-----	7.37 (5.42)	7.50				
Even slower	Control ($n=96$)	-----	8.43 (6.17)	8.43	−0.95	1.13	0.00	0.03
	Mindfulness ($n=149$)	-----	8.52 (6.50)	8.52				
Flanker task								
Fish-congruent	Control ($n=85$)	9.20 (3.04)	10.62 (2.27)	10.63	−0.72	0.40	0.07	14.86*
	Mindfulness ($n=131$)	9.31 (2.90)	10.50 (2.44)	10.47				(14.91*)
Fish-incongruent	Control ($n=85$)	4.61 (2.42)	5.58 (2.38)	5.64	−0.40	0.84	0.00	0.49
	Mindfulness ($n=131$)	4.89 (2.27)	5.90 (2.43)	5.86				
Arrow attempted	Control ($n=85$)	24.7 (21/85)	45.9 (39/85)	46.00	−2.67	24.45	0.91	0.09
	Mindfulness ($n=131$)	25.2 (33/131)	51.1 (67/131)	56.89				(5.38*)
DCCS	Control ($n=89$)	8.03 (4.33)	10.28 (3.97)	10.49	−0.65	1.34	0.00	0.46
	Mindfulness ($n=133$)	8.95 (4.16)	10.97 (4.01)	10.83				

*$p<0.05$ (two-tailed). $^+p<0.10$ (two-tailed). Standard deviations or counts are listed in parentheses after means or percentages, respectively. Sharing Task: Most Liked = average percentage of stickers given to most liked peer (versus the self). Least Liked = average percentage of stickers given to least liked peer (versus the self). Unfamiliar = average percentage of stickers given to an unknown child (versus the self). Sick = average percentage of stickers given to a sick child (versus the self). In Need = average percentage of stickers given to a *sick* child (versus *most*, *least*, or *unfamiliar child*). Others = average percentage of stickers given to another child (versus the self) aggregated across most, least, unfamiliar, and sick trials. Balance Beam Task: Walk = average time in centiseconds to cross balance beam. Slower = average time in centiseconds to cross balance beam with instructions to go slower than *walk trial*. Even Slower = average time in centiseconds to cross balanced beam with instructions to go even slower than *slower trial*. Flanker Task: Fish-Congruent = average number of correct responses for congruent trials. Fish-Incongruent = average number of correct responses for incongruent trials. Arrow Attempted = percentage of children successfully reaching arrow trials. *DCCS* Dimensional change card sort task. $Post_{adj}$ is the posttest mean adjusted for pretest scores. $Post_{adj}$ for Arrow Attempted is the posttest percentage of children successfully reaching arrow trials adjusted for average pretest success. η_p^2 = Partial eta square for the effect of condition on the outcome variable with pretest score as a covariate. For Arrow Attempted, η_p^2 is the odds ratio for the effect of condition on success at reaching arrow trials at the posttest (adjusted for pretest success). $F = F$-value for the difference in the outcome variable by condition with pretest score as a covariate. For Arrow Attempted, the value listed in the F column is the chi-square Wald statistic for the prediction of reaching the posttest arrow trials with success at reaching pretest arrow trials as a covariate. For Fish-C the value in parentheses is the F-value for the Pretest x Condition interaction. For Slower and Even Slower, the two F-values are for the difference in the outcome variable by condition with Walk score or Slower score as the covariate, respectively. For Fish-C, the F-value in parentheses is for the interaction between condition and the pretest score covariate. For Arrow Attempted, the F-value in parentheses is the chi-square Wald statistic for the prediction of reaching posttest arrow trials by the interaction between experimental condition and reaching pretest arrow trials

Table 4 Adjusted posttest means by experimental condition at 1 *SD* above and below pretest means for significant covariate interactions

Measure	Condition	Pretest			*F*
		−1 *SD*	Mean	+1 *SD*	
Fish-congruent	Control ($n=85$)	10.18	10.64	11.10	14.91*
	Mindfulness ($n=131$)	8.92	10.48	12.03	
Arrows attempted	Control ($n=85$)	39.06	46.00	66.66	2.15*
	Mindfulness ($n=131$)	36.73	56.89	93.94	
BRIEF-BI	Control ($n=92$)	2.19	2.46	2.74	4.82*
	Mindfulness ($n=134$)	2.20	2.60	2.99	
BRIEF-EC	Control ($n=92$)	2.31	2.55	2.78	3.59^{+}
	Mindfulness ($n=134$)	2.25	2.59	2.94	
TS-Gold SE	Control ($n=85$)	4.56	5.10	5.63	27.85*
	Mindfulness ($n=107$)	4.11	5.03	5.95	
TS-Gold C	Control ($n=85$)	4.34	4.68	5.03	51.53*
	Mindfulness ($n=107$)	3.94	4.75	5.55	
TS-Gold PD	Control ($n=85$)	5.56	6.07	6.58	16.75*
	Mindfulness ($n=107$)	5.50	6.33	7.16	
TS-Gold L	Control ($n=85$)	4.82	5.49	6.17	18.43*
	Mindfulness ($n=107$)	4.51	5.46	6.41	
TS-Gold M	Control ($n=85$)	2.32	3.04	3.54	9.47*
	Mindfulness ($n=107$)	2.19	3.12	3.77	
TS-Gold Li	Control ($n=84$)	2.08	2.84	3.60	9.96*
	Mindfulness ($n=107$)	2.13	3.14	4.14	

*$p<0.05$ (two-tailed). $^{+}p<0.10$ (two-tailed). Fish-Congruent = average number of correct responses for Flanker congruent trials. Arrow Attempted = percentage of children successfully reaching Flanker arrow trials. BRIEF measures: *BI* Behavioral inhibition; *EC* Emotional control. TS-Gold Measures: *SE* Social-emotional; *C* Cognitive; *PD* Physical development; *L* Language, *M* Math; *Li* Literacy. *F* *F*-value for the Pretest x Condition interaction. For Arrow Attempted, the *F*-value is the logistic regression coefficient for the prediction of reaching posttest arrow trials by the interaction between condition and reaching pretest

statistically significant, $F(1, 223)=2.58$, $p=0.11$, the interaction between pretest scores and the experimental condition was statistically significant, $\eta_p^2=0.02$, $F(1, 223)=4.82$, $p=0.03$. As shown in Table 4, there was little difference between conditions in ratings of behavioral inhibition for children with low pretest scores, but ratings of behavioral inhibition were higher in the MBKC condition than in the CAU condition for children with average and high pretest scores.

For the TS-GOLD subscales, one agency with two classrooms did not use TS-Gold, so the sample size for this measure is smaller ($n=191$). Covariate analyses revealed statistically significant mean differences between experimental conditions for Social-Emotional, Cognitive, Physical Development, Language, and Mathematics subscale ratings, all $\eta_p^2>0.04$, $F(1, 187–188)>7.28$, $p<0.008$. A marginally significant difference in Literacy ratings also was found, $\eta_p^2=0.02$, $F(1, 188)=3.19$, $p=0.076$. Notably, all of these effects of experimental condition were qualified by statistically significant interactions between pretest scores and experimental condition, all $\eta_p^2>0.04$, $F(1, 187–188)>9.47$, $p<0.003$. As shown in Table 4, for children with low pretest scores there was little difference between experimental condition in ratings of physical development and literacy. However, for children with average and high pretest scores, ratings of physical development and literacy were higher in the MBKC condition than in the CAU condition. Also, there was little difference between experimental conditions in ratings of social-emotional skills, cognitive skills, language, and math for children with average pretest ratings. For children with low pretest ratings, ratings of these skills posttest were lower for those in the MBKC condition than for those in the CAU condition. In contrast, for children with high pretest ratings, posttest ratings of these skills were higher for those in the MBKC condition than for those in the CAU condition.

Parents' Ratings of Children

Table 6 lists descriptive statistics, confidence intervals, effect sizes, and *F*-ratios for covariate analyses of parents' ratings of children. Covariate analyses revealed no statistically significant effects of experimental condition for either the Affect Contagion or Other-Oriented Concern subscales of the Griffith Empathy measure, both *F*-values, $F(1, 162)<1.55$, $p>0.21$. However, for the Cognitive Empathy subscale, covariate analyses revealed a statistically significant effect of experimental condition, $\eta_p^2=0.05$, $F(1, 162)=8.74$, $p=0.004$, such that

Table 5 Teachers' mean (standard deviation) self-reports of children before and after intervention by experimental condition

Measure	Condition	Assessment time			95% CI		η_p^2	*F*
		Pre	Post	$Post_{Adj}$	LL	UL		
TRSC								
PB (0.96, 0.96)	Control ($n=91$)	2.55 (1.41)	2.91 (1.32)	3.07	0.26	0.74	0.07	16.98*
	Mindfulness ($n=135$)	2.99 (1.11)	3.68 (1.03)	3.57				
ESR (0.92, 0.93)	Control ($n=91$)	2.98 (1.20)	3.28 (1.20)	3.43	−0.04	0.38	0.01	2.48
	Mindfulness ($n=135$)	3.33 (1.04)	3.70 (1.05)	3.59				
EB (0.91, 0.91)	Control ($n=91$)	2.35 (1.34)	2.69 (1.37)	2.90	0.27	0.73	0.08	18.33*
	Mindfulness ($n=135$)	2.85 (1.17)	3.54 (1.09)	3.40				
BRIEF-P								
BI (0.97, 0.96)	Control ($n=92$)	2.50 (0.64)	2.46 (0.60)	2.46	0.02	0.25	0.01	2.58
	Mindfulness ($n=134$)	2.52 (0.52)	2.60 (0.49)	2.60				(4.82*)
EC (0.94, 0.94)	Control ($n=92$)	2.62 (0.54)	2.56 (0.58)	2.55	−0.07	0.17	0.01	2.84^+
	Mindfulness ($n=134$)	2.57 (0.50)	2.58 (0.50)	2.60				(3.59^+)
TS (0.92, 0.92)	Control ($n=92$)	2.59 (0.53)	2.61 (0.53)	2.62	−0.02	0.18	0.01	2.78^+
	Mindfulness ($n=134$)	2.61 (0.41)	2.71 (0.37)	2.71				
WM (0.97, 0.97)	Control ($n=92$)	2.47 (0.62)	2.46 (0.64)	2.49	0.03	0.26	0.03	6.04*
	Mindfulness ($n=134$)	2.55 (0.46)	2.64 (0.43)	2.63				
PO (0.94, 0.93)	Control ($n=92$)	2.43 (0.60)	2.46 (0.62)	2.49	0.03	0.25	0.03	6.21*
	Mindfulness ($n=134$)	2.53 (0.46)	2.65 (0.40)	2.63				
TS-GOLD								
SE (0.95, 0.93)	Control ($n=84$)	3.93 (1.12)	4.96 (0.85)	5.10	−0.22	0.08	0.13	29.05*
	Mindfulness ($n=107$)	4.45 (1.01)	5.22 (0.91)	5.03				(27.85*)
C (0.95, 0.94)	Control ($n=85$)	3.80 (0.79)	4.59 (0.63)	4.68	−0.06	0.19	0.20	47.67*
	Mindfulness ($n=107$)	4.19 (0.86)	4.91 (0.63)	4.75				(51.53*)
PD (0.88, 0.84)	Control ($n=85$)	5.31 (0.85)	5.99 (0.79)	6.07	0.11	0.41	0.06	12.40*
	Mindfulness ($n=107$)	5.57 (0.95)	6.43 (0.95)	6.33				(16.75*)
L (0.94, 0.94)	Control ($n=85$)	4.44 (1.02)	5.30 (0.84)	5.49	−0.16	0.10	0.09	18.94*
	Mindfulness ($n=107$)	4.98 (1.02)	5.68 (0.97)	5.46				(18.43*)
M (0.87, 0.89)	Control ($n=85$)	2.22 (0.63)	2.82 (0.66)	3.04	−0.04	0.20	0.04	7.28*
	Mindfulness ($n=107$)	2.71 (1.05)	3.33 (1.10)	3.12				(9.47*)
Li (0.87, 0.92)	Control ($n=85$)	2.00 (0.55)	2.63 (0.68)	2.84	0.17	0.43	0.02	3.19^+
	Mindfulness ($n=107$)	2.39 (0.91)	3.36 (1.23)	3.14				(9.96*)

$^*p<0.05$ (two-tailed). $^+p<0.10$ (two-tailed). Cronbach's alphas for scales are listed in parentheses beneath measure names. Standard deviations are listed in parentheses after means. *TRSC* Teacher rated social competence; *PB* Prosocial behavior; *ESR* Emotional self-regulation; *EB* Empathic behavior. *BRIEF-P* Behavior rating inventory of executive function-preschool version; *BI* Behavioral inhibition; *EC* Emotional control; *TS* Task shift; *WM* Working memory; *PO* Planning/Organization. *TS-GOLD* Teaching strategies-GOLD; *SE* Social-emotional; *C* Cognitive; *PD* Physical development; *L* Language; *M* Math; *Li* Literacy. $Post_{adj}$ is the posttest mean adjusted for pretest scores. η_p^2 = Partial eta square for the effect of condition on the outcome variable with pretest score as a covariate. *F* F-value for the difference in the outcome variable by condition with pretest score as a covariate. *F*-values in parentheses are for the effect on the outcome variable of the interaction between condition and the pretest score covariate

MBKC children were rated as higher in cognitive empathy ($M_{adj}=6.24$) than were children in the CAU condition ($M_{adj}=5.75$). Also, on the ASQ-SE, children in the MBKC condition were rated higher on social-emotional competency ($M_{adj}=10.49$) than were CAU children ($M_{adj}=8.85$), but this difference was only marginally significant, $\eta_p^2=0.02$, $F(1, 146)=3.49$, $p=0.064$.

Discussion

The present study replicated and extended research by Flook et al. (2015) to evaluate the application and potential benefits of the MBKC in a longitudinal, multi-site study with 16 classrooms (ethnically and socioeconomically diverse 3 to 5-year-olds) by including more comprehensive measures of

Table 6 Parents' mean (standard deviation) self-reports of children before and after intervention by experimental condition

Measure	Condition	Assessment time			95% CI		η_p^2	F
		Pre	Post	$Post_{Adj}$	LL	UL		
Griffith empathy								
CE (0.69, 0.68)	Control ($n=69$)	5.86 (1.29)	5.71 (1.30)	5.75	0.16	0.82	0.05	8.74*
	Mindfulness ($n=96$)	6.00 (1.30)	6.27 (1.24)	6.24				
AC (0.82, 0.83)	Control ($n=69$)	5.35 (1.27)	5.83 (1.12)	5.84	−0.53	0.12	0.01	1.55
	Mindfulness ($n=96$)	5.40 (1.34)	5.65 (1.29)	5.64				
OOC (0.74, 0.79)	Control ($n=69$)	6.34 (1.21)	6.26 (1.35)	6.21	−0.21	0.44	0.00	0.48
	Mindfulness ($n=96$)	6.19 (1.30)	6.28 (1.26)	6.32				
ASQ-SE (0.92, 0.92)	Control ($n=66$)	9.99 (8.04)	9.18 (7.06)	8.85	−0.10	3.37	0.02	3.49+
	Mindfulness ($n=83$)	9.14 (6.97)	10.23 (7.67)	10.49				

*$p<0.05$ (two-tailed). +$p<0.10$ (two-tailed). Cronbach's alphas for scales are listed in parentheses beneath measure names. Standard deviations are listed in parentheses after means. Griffith Empathy Measure: *CE* Cognitive empathy; *AC* Affect contagion; *OOC* Other-oriented concern. *ASQ-SE* Ages and stages questionnaire-social emotional. $Post_{adj}$ is the posttest mean adjusted for pretest scores. η_p^2 = Partial eta square for the effect of condition on the outcome variable with pretest score as a covariate. *F* *F*-value for the difference in the outcome variable by condition with pretest score as a covariate

social-emotional and executive functioning, and a measure of children's mindfulness skills. Generally, results indicated better outcomes for children in the MBKC condition than children in the CAU condition when controlling for pretest scores on the outcome measures. The beneficial effects of the MBKC condition were most apparent for teacher ratings of children's social-emotional skills, executive functioning, and academic skills. Parents, as well, gave higher ratings of MBKC children than CAU children in regard to cognitive empathy and social-emotional skills. Children's task-based assessments provide support for the benefits of the MBKC but to a lesser extent. Although no differences were found between MBKC children and CAU children on behavioral inhibition (balance beam) and some executive functioning tasks (e.g., DCCS), MBKC children did show evidence of greater sharing of stickers with a child in need, as well as greater sharing with other children in general versus keeping stickers for themselves. In contrast to teachers' and parents' reports, children's reports of their own mindfulness skills and social self-efficacy offered little evidence of a benefit from the MBKC. Still, of the 37 outcome measures, there was only one instance in which MBKC children showed significantly lower benefit than CAU children (i.e., children's self-report of self-regulated learning). Children's ratings of themselves were less internally consistent than parent and teacher ratings of children, perhaps suggesting greater weight should be placed on parent and teacher reports in this very young age group.

This study explored the potential added benefit of mindfulness training in classrooms already using a social emotional learning (SEL) curriculum. The TS-Gold developmental assessment was only used in the 14 classrooms using the Pyramid SEL curriculum, and findings were not in line with our second hypothesis or previous research (e.g., Flook et al., 2015; Sun et al., 2021) that suggested children with lower baseline scores would benefit most from training. Instead, we found that MBKC children with average or high pretest scores (e.g., on health, literacy, math) benefitted more than CAU children. Further, for those with lower pretest scores in some areas (e.g., cognitive, language, math), CAU children benefitted more than MBKC children. Perhaps, in this young age group with SEL experience, average and higher functioning children may apply the benefits of MBKC training to academics more quickly, suggesting that longer term follow up and comparisons across different types of outcomes would be beneficial. The tendency for higher functioning children to benefit more from the MBKC than lower functioning or CAU children was also true for Flanker inhibitory control and BRIEF behavioral inhibition.

By and large, most significant findings supporting the additive benefit of the MBKC on academic maturation in SEL programs hailed from teacher reports of significant positive changes in prosocial behaviors, empathic behaviors, executive functioning (particularly planning, organization, and working memory), social-emotional skills, physical development, and literacy. Some validation for teacher perceptions was observed in parental reports of increased cognitive empathy and increased social-emotional competency among those in the MBKC condition compared to the CAU condition.

Teacher fidelity and acceptability data suggest that trained classroom teachers can effectively implement the MBKC, whereas in previous MBKC studies mindfulness experts implemented it. Teachers also found their own mindfulness and MBKC training useful and intended to keep using the MBKC.

Limitations and Future Directions

Trained teachers were not blind to condition, a limitation found in much of the extant literature (e.g., Bockmann & Yu, 2022; Razza et al., 2020). This lack of blindness poses a possible explanation for why our results did not mirror those of past studies in finding that lower functioning children benefitted more from mindfulness training. Teachers may have been biased in their expectations and behaviors toward the average or higher functioning children and focused more attention on their acquisition and application of mindfulness skills compared with the lower functioning children. Consequently, it is worth comparing the present results to the small subset of existing studies without this limitation. Specifically, results from a well-controlled study with blind raters by Razza et al. (2015) suggested mindfulness interventions successfully promoted effortful control, executive functioning, and sustained attention, with more pronounced effects for children particularly low in self-regulation skills at pretest. However, these results were only found for teachers' reports and were not mirrored in reports by parents. Thus, despite the presence of a common methodological limitation of much existing research on mindfulness and children, the present findings of positive impact of MBI converge with those of other studies lacking this limitation (e.g., Razza et al., 2015).

We concur with past researchers' conclusions that direct child measures with this young age group, especially those using rating scales, are challenging and a potential limitation in any research with young children (McKown, 2019). Child measures of executive functioning on the DCCS and some Flanker measures did not mirror teacher reported gains in executive functioning. Given that parent reports of children's empathy and social-emotional skills paralleled those of teachers' and potentially reflect whether children are using mindfulness skills at home, future studies should make a greater effort to measure parents' perspectives on child outcomes such as executive functioning and self-regulation. Involving parents in MBIs might also promote generalization of children's mindfulness and self-regulation skills outside the classroom, as other researchers have recommended (e.g., Bockmann & Yu, 2022).

One of the primary goals of the MBKC was to increase awareness of needs in others and cultivate kindness, compassion, and social-emotional competence when engaging with others. Notably, reports across children, parents, and teachers suggest prosocial behaviors (e.g., sharing, cognitive empathy) and children's awareness of others were more consistently reported and more evident in MBKC children than in CAU children. Similarly on the sharing task, MBKC children shared more with a sick child (vs. the self), suggesting higher empathy for a child in need. Future research may want to capitalize on these findings and include instruction and assessment of nonjudgmental acceptance, fairmindedness, and kindness to unknown others in need to promote and evaluate more generalizable awareness of others and prosocial behavior.

Two additional areas warrant further attention. First, the discrepancy between children's self-perceptions of mindfulness skills, like other-oriented kindness, and teacher reports of empathy warrants clarification. There were no significant differences between MBKC and CAU children on the mindfulness measure (MCATS), whereas teachers and parents rated MBKC children as more socially competent and empathetic. Speculatively, it may be that teachers and parents are more skilled in recognizing these areas of growth in children as they interact with other children. Alternatively, it may be that teachers' reports are biased as they were not blind to study condition and may have been invested or inclined to see more growth or development in the MBKC children given the teachers delivered the MBKC protocol. The latter seems less likely given the consistency of the present study findings with previously mentioned double-blind RCTs examining teachers' reports of children's development following a mindfulness protocol.

Second, children in the CAU condition endorsed greater increases in self-efficacy, particularly for self-regulatory learning, than did children in the MBKC condition. The self-regulated learning subscale looks at things like keeping your mind on school, getting yourself to do a task when there are other fun things to do, and remembering what you were taught. With MBKC training, children may become more objectively aware of challenges with self-regulation, making them less inclined toward the usual overly positive, less internally consistent self-ratings made by young children (Chambers & Johnston, 2002). MBKC children may be more cognizant of times when they are not as successful as they would like to be in these areas or are more willing to acknowledge these less successful experiences due to an increased ability to be nonjudgmental with themselves. Another possible explanation is that children engage in social comparison when going through the MBKC, and when comparing themselves to other children (e.g., fictional characters in stories or as highlighted by teachers) they conclude they are not as skillful as other children.

Ultimately, the present study extends and contributes to the developing literature on the application of mindfulness with at-risk preschool children and reinforces the benefits of teaching young children mindfulness, even within existing SEL curricula. Trained teachers showed strong MBKC adherence and found the MBKC valuable and feasible in the classroom. Teachers and other researchers have noted that mindfulness approaches pair well with SEL approaches (e.g., Kim et al., 2020). Both SEL programs and MBIs promote social-emotional skill development but MBIs also promote additional skills such as self- and other-acceptance

and kindness. Integrating MBIs with SEL programs deserves further research attention, particularly for preschool children (Berti & Cigala, 2022). This study paid teachers to attend training and supported implementation with mindfulness coaches, which may help to ensure attention to core components of the mindfulness curriculum (Doyle et al., 2019). Future research could also explore whether teachers' receptiveness to mindfulness training affects the potential benefits within the classroom and their own well-being (e.g., reduced stress). Overall, mindfulness can be successfully implemented by trained preschool teachers to encourage self-, emotion-, and behavior-regulation skills particularly as they apply to prosocial skills, social-emotional development, and executive functioning in the classroom, all of which are paramount for successfully navigating personal and academic opportunities.

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Author Contributions BAH: designed and executed the study, assisted with the data analyses and writing of the paper. PYH: collaborated on study design and writing of the paper. KRI: designed and executed the study, assisted with the data analyses and writing of the paper. DAL: performed data analyses and collaborated on writing the paper. All authors contributed substantially to the paper and are therefore listed alphabetically. All authors approved the final version of the manuscript for submission.

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Data Availability The data analyzed in this paper will be made available by the authors upon request to qualified researchers.

Declarations

All data were collected in compliance with IRB approval.

Ethics Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of Lawrence University and the University of Wisconsin Oshkosh Institutional Review Boards, the Appleton Area School District Board of Education, and all participating programs, and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent In accordance with the universities' IRBs, written informed consent was obtained from the parents of the children and verbal assent was obtained from the children in the study.

Conflict of Interest The authors received some support from the grants and their institutional positions. BAH has served and KRI currently serves on the board of directors of the Community Early Learning Center agencies, and neither received compensation as member of the board of directors. The authors declare that they have no other competing interests.

Use of Artificial Intelligence No artificial intelligence tools were used in this project.

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